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# Near East/South Asia Report

No. 2733

## MOROCCO: ENERGY OUTLOOK FOR YEAR 2000

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MOROCCO: ENERGY OUTLOOK FOR YEAR 2000

Development of Hydraulic Energy

Casablanca LE MATIN DU SAHARA in French 24 Feb 83 pp 4-5

[Article: "Large-Dam Policy in Morocco; Evaluation and Prospects of Hydroelectric Power"]

[Text] Water, the main constituent of all living organisms and an essential factor in any economic activity, conditions all socioeconomic development in the country. No harmonious agricultural, industrial, touristic or urban development is possible unless the kingdom's water resources are ever more extensively used. Throughout the world, countries are beginning to consider that, far from being a gift from heaven, water is a commodity that could be in short supply sooner or later.

As far as our country is concerned, it is estimated that an average of 30 billion cubic meters of water fall on the national territory every year; they are distributed as follows:

- 20 billion cubic meters are drained by the wadis; they provide the surface water.

- 10 billion cubic meters infiltrate into the ground and feed water-bearing beds.

Twenty-one billion cubic meters of this water can be used; recovery of the remaining 9 billion is not considered economically feasible for the time being.

The minister of equipment attaches the greatest importance to water as a precious resource and a strategic commodity representing one determining factor--if not the only determining factor--in economic and social development.

Our country has made great efforts to mobilize its water resources, either through dam-building or through underground water exploration. These efforts were intensified after independence and involved all regions of the kingdom; as a result, close to 50 percent of our resources are now being used.

Thus, Morocco now has 31 dams which are used for irrigation and to produce electricity and drinking water. They have a total water storage capacity of 10 billion cubic meters. They cover an area of 530,000 hectares and irrigate at present close to 420,000 hectares in addition to the 300,000 irrigated by small and medium-size projects, either through water derivation or pumping of water-bearing beds. The total area now irrigated thus exceeds 720,000 hectares.

As far as hydroelectric power is concerned, production has doubled during the last decade; it is now close to 2 billion kWh/year. Considering the high price of oil products, which places a heavy burden on our balance of payments and increases our energy dependence on foreign countries, the country will continue to make considerable efforts in years to come to mobilize its water resources and thus cover most of our energy requirements.

Similarly, the drinking-water sector has experienced considerable growth to meet the rapidly increasing needs of the populations as well as those of industry and tourism, more especially in large towns; as a result, production has been multiplied ninefold since independence and it now exceeds 700 million cubic meters per year.

His Majesty's government's objective is to mobilize close to 20 billion cubic meters by 2000 (i.e. twice as much as now), including 4-5 billion cubic meters of underground water. It will then be possible to irrigate 1.2 million hectares, to produce 4.5 billion kWh of electricity per year, and to supply 2.5 billion cubic meters of drinking water to rural and urban centers.

Distribution of Surface Water in Morocco

Since it finds itself in a semi-arid zone, Morocco is considered to be one of the countries whose water resources are very poorly distributed, both in space since climate variations result in considerable interregional imbalance (some regions receive less water than others), and in time since the climate is variable and characterized by irregular rainfall periods and drought years which have a disastrous effect on the country's development in general and more especially on agricultural development, which is a priority objective of the 1981-1985 development plan.

Morocco can be divided into four different climate zones:

1. The northwest zone, which extends from the Chaouen-Tetouan-Tangiers area to the Loukkos and Ourgha valleys and is characterized by abundant surface water resources. This zone alone possesses 50 percent of the available surface water resources.

2. The zone northwest of the Upper Atlas, which is characterized by average rainfalls and receives most of its water from the wadis draining the Upper Atlas. This zone possesses 33 percent of the available resources. This region, where the country's economic activity is concentrated, is characterized by considerable expansion due to its high rate of demographic growth and to the rural exodus to the country's large urban centers; as a result, it will not

be possible to meet its water requirements in the medium term. Part of the resources of the first zone will therefore have to be diverted to this zone to remedy shortages that will appear around 2000.

3. A zone located southeast of the Upper Atlas, from the Al-Hoceima-Nador-Oujda area to the Agadir area. It is shaped like a crescent hugging the Upper Atlas mountain range. In spite of its large size, this semi-arid region possesses only 17 percent of the available water resources. It is also characterized by the fact that it does not have enough surface water to meet its water requirements.

4. The Sahara zone, which is characterized by its aridity and the complete lack of available surface water resources.

To remedy climate irregularities throughout these four regions--both from year to year and from one region to the next--it has been found necessary to make full use of the water resources available in each of them. In arid zones, water has been pumped from water-bearing beds, whereas in areas where surface water is abundant it has been used as described below.

Surface Water Mobilization

Prior to Independence

The policy of the colonial power consisted in building smaller dams in areas which it had colonized and where existing requirements had to be met at the lowest possible cost; thus, zones with considerable potential water resources were provided with dams which, in certain cases, could have been dimensioned so as to protect sites that were suitable for the construction of large dams; as an example, we would mention the Sidi Said Maachou dam on wadi Oum Er-Rabia, which uses only 1 cubic meter per second to supply drinking water to Casablanca, whereas the average annual module of this wadi is 117 cubic meter per second.

All in all, dam construction and large water development projects led only to mediocre overall results: in 30 years, only 13 dams were built, with a total storage capacity of 1.97 billion cubic meters and a harnessing capacity of 1.5 billion cubic meters per year, i.e. less than 10 percent of the surface water volume that could be harnessed (16 billion cubic meters). The following table lists some of the main dams built before independence, i.e. until 1956.

| Dam | Year Placed In Service | Volume Harnessed (mil. $m^3$/yr.) | Irrigation Area (hectares) | Areas Irrigated |
|---|---|---|---|---|
| Oued Mellah | 1931 | 15 | 150 | Mellah |
| Ali Thelat | 1934 | 20 | 1,400 | Oued Lao |
| El Kansera | 1935 | 160 | 20,000 | Sidi Slimane |
| Lalla Takerskorst | 1935 | 35 | 4,000 | Central Haouz |
| Kasba Tadla | 1935 | 280 | 23,500 | Beni Amir |
| Imfout | 1944 | 400 | 40,000 | Doukkala |
| Bine El Ouidane | 1944 | 880 | 63,000 | Beni-Moussa |
| Total | | 1,790 | 152,350 [as published] | |

After Independence

Since 1956, Morocco has been able to make considerable efforts to strengthen its hydraulic network by multiplying surface-water mobilization systems. This new momentum is characterized by the following two periods:

- Prior to 1967: This decade, during which Morocco's dam policy was not yet well defined, was nevertheless marked by the completion of the following projects:

- The Mohammed-V dam on wadi Moulouya with a 726-billion cubic meter storage capacity: it supplies irrigation water to 65,400 hectares in the Triffa, Zebra and Bou-Areg areas on the lower Moulouya, and produces some 85 million kWh of electricity per year. It was placed in service in 1967.

- The Nakhla dam on wadi Nakhla, with a 9-million cubic meter water storage capacity: it supplies drinking water to the town of Tetouan and irrigation water to a small 700-hectare area in Martil.

- The Safi dam with a 2-million cubic meter storage capacity: it supplies drinking water to Safi and industrial water to chemical plants. It was placed in service in 1965.

This decade can be considered as a transition which made it possible to assess the country's water resources and define what water-utilization objectives would lead to intensified development.

- After 1967: A second stage started in 1967 when His Majesty King Hassan II gave new impetus to the dam policy, the objective being to irrigate 1 million hectares by 2000. During 1967, the creation of a Directorate of Hydraulics was decided; its objectives were as follows:

- To look for and evaluate water resources.

- To plan their use.

- To make laws concerning water utilization.

- To build the six dams listed below, which represent the first stage in a vast and ambitious dam-construction program:

. Moulay Youssef dam on wadi Tessaout
. Hassan Addakhil dam on wadi Ziz.
. Mansour Ed-Dahbi dam on wadi Draa.
. Youssef Ben Tachfine on wadi Massa.
. Sidi Mohammed Ben Adbellah dam on wadi Bouregreg.

In addition to these dams, after 1967, the Directorate of Hydraulics also raised the El Kansera dam in 1969 and built three dams: the wadi El Makhazine dam on the Loukkos, the Ibn Batouta dam on the Mharhar (Tangiers water supply) and the Al Massira dam on the Oum Er-R'bia. After 1979, the Mohamed Ben

Abdelkrim Al Khatabi dam was built on wadi Uekor, the Tamzaourt dam on wadi Issen, the Sidi Driss dam on wadi Lakhdar, a safety dam on wadi Loukkos, and the Timinoutine compensation dam downstream from the Moulay Youssef dam; the Lalla Takerkoust dam on the N'fis was also raised.

This comprehensive large-dam construction program reflected the objectives and orientations defined in our country's various development plans which strived to overcome social inequalities, develop interregional solidarity as far as water is concerned, reduce our energy dependence on foreign countries, irrigate one million hectares and meet the nation's drinking and industrial water requirements.

## Irrigating One Million Hectares

The agricultural policy implemented until now was based on three orientations:

- Meeting the country's requirements for agricultural staple products.
- Developing agricultural exports.
- Improving farmers' incomes.

If these objectives are to be achieved, water resources must be first developed, as they alone will make it possible to achieve the objective set by His Majesty King Hassan II: to irrigate one million hectares by 2000.

At present, completed dams and dams under construction cover an irrigation area of some 530,000 hectares, of which 420,000 are already equipped and irrigated (in addition to the 300,000 hectares irrigated by small and medium projects).

Dam projects included in the present plan will increase the area covered from 530,000 hectares to 650,000 hectares. At the present rate of equipment, it is obvious that the objective--irrigating one million hectares--will be achieved well before 2000.

## Drinking and Industrial Water Supply

On the eve of independence, the drinking water requirements of urban and rural centers were unevenly met throughout the country, some urban areas being privileged in this respect. Therefore, drinking-water supply was designed to meet specific requirements and called on resources that could be used easily, mainly spring waters and ground-water tables. Existing infrastructures consisted only of galleries, "guettaras," drains and gravel pipes.

During the first ten years after independence, expansion remained relatively slow; it was ensured by water supply programs that always used the nearest resources. The objective was to meet as well as possible the requirements of all towns. As a result, it reconciled the social aspects of meeting household requirements with the imperatives of the country's economic development. The second decade was characterized by a rapid growth of drinking-water consumption resulting from the kingdom's economic development, town-planning development and the improvement of the standard of living.

This resulted in an average growth in demand of 90 percent per year during the period following the second decade. Forecasts based on this observation are given in the following table.

| Urban Category | Requirements (cubic meters per second) 1980 | 1985 | 1990 | 2000 |
|---|---|---|---|---|
| Large towns | 15.4 | 22.5 | 30.6 | 55.6 |
| Medium towns | 4.0 | 5.2 | 7 | 11.3 |
| Small towns | 1.4 | 2.0 | 2.5 | 4.0 |
| Total | 20.8 | 29.7 | 40.1 | 70.9 |

In addition, we should mention the heavy water requirements of certain industrial projects aimed at developing key sectors of the country's economy: Safi (MC, MP1 and MP2) and Jorf Lasfar chemical plants, Nador steelmaking complex, etc.

In view of the very rapid growth of the urban population's requirements and the development of industrialization, and in anticipation of a saturation of resources, it was decided to intensify efforts to utilize surface water so as to cover the country's needs beyond 1985 and, if possible, until 1990. This effort involves not only urban centers, but all rural communities as well, in order to attenuate regional and social inequalities and remedy the shortages which affect more especially the underprivileged zones touched by drought. For certain large urban centers--where water resources are admittedly inadequate or at least limited considering the rapid growth in demand--it has become indispensable and in some cases urgent to consider retaining dams for surface water. One striking example is that of the drinking-water supply on the Atlantic Coast (Rabat-Sale-Casablanca) where large-scale development has taken place to meet requirements, namely the Bouregreg dam with a retaining capacity of 500 million cubic meters. We should also mention the Ibn Batouta dam which supplies drinking water to Tangiers, and the projected dams included in the 1981-1985 Five-Year Plan to supply water to Taza, Tetouan and Essaouira.

Dam Policy To Reduce Social Inequalities

As we already pointed out, water distribution in our country is uneven, both in time and in space, which results in social inequalities in our regions. To reduce these social and regional inequalities, measures were adopted as ordered by His Majesty King Hassan II in order to utilize all existing resources in the regions most affected by water shortages. As a result, two large dams were built in pre-Saharian regions overlooking the Tafilalet and the Draa valley:

- The Hassan Addakhil dam was built to regulate wadi Ziz waters and to provide irrigation water for the Ziz valley and Tafilalet plain (20,760 inhabitants) palm groves, while protecting these regions against floods and contributing to meet the population's water requirements.

- The Mansour Ad-Dahbi dam was built on wadi Draa to regulate its waters and to irrigate the Ouarzazate (19,000 inhabitants) area, protect it against floods and provide water for the people. In addition, this dam is equipped with a water-power plant producing an average of 27,106 kWh/year.

In addition to the realization of these two large dams, we should mention the development of the overall water-supply network in the areas covered, which required considerable effort on the part of the state and will make it possible to improve the development of this area. In addition to these two dams, we should mention the two projected dams in the Guir and Bouanane basins, at the sites called Kaddousser and Jbel Lakhal: together, these projects will cover an area estimated at 6,700 hectares, and they could be completed under the present Five-Year Plan.

In addition to these large dams, a vast program has been launched to make an inventory of possible sites for collinear and flood-discharge dams that would enable most of the people to benefit from the development of the country. The collinear dams which the Hydraulics Administration is now considering are the following:

- Collinear dams in the Tanguist area (Takkarat dam on wadi Joumou, Beni Gmil dam on wadi Beni Gmil and Beni Bouafrah dam on wadi Bouafrah) whose primary purpose is to regulate the wadis on which they are built and supply drinking and agricultural water to the areas covered, which represent a total of 1,190 hectares. The wadi Takkarat dam will also supply water to Targuist.

- The Smir dam in the Tetouan area, which will contribute to the drinking-water supply of Tetouan and the surrounding area, and possibly to the irrigation of an agricultural area downstream.

- The five collinear dams in the Oujda province, at the following sites: Msakhskha on wadi Msakhskha, Oglat on wadi Oglat, Sidi Ali on wadi Sidi Ali, Guelb Khneg el Hdda on wadi Mssaid, and Tarit on wadi Tarit. These dams will serve to irrigate smaller areas and provide drinking water to neighboring villages.

- Collinear dams in the province of Nador at the following sites: Baaj on wadi Baaj, Souk Tiet Boubker on the Ighane, and Ajn Massaouda on wadi Kert. These dams will provide drinking water for the villages and possibly also to irrigate smaller areas.

The construction of these large and small dams, together with the economic development of the regions in which they are located, will contribute to reduce the rural exodus toward large urban centers.

Interregional Solidarity For Water

We have already said that Morocco consists of one zone with abundant water and others with very limited resources. If the country's development is to be harmonious, we must not concentrate all of our activity in just one zone, but decentralize it throughout the territory. To achieve this, master plans

for the Oum Er Rbia, Central Haouz and Sebou basins have been prepared and provide for a distribution of water, especially surface water resources.

As a result of the interregional solidarity policy for water, the following water transfers have been decided:

- The Bine El Ouidane dam, which regulates 887 million cubic meters of water per year and contributes to irrigate downstream Tessaout areas with a volume of 170 million cubic meters per year. [as published]

- The Al Massira dam will reserve a regulated volume of 900 million cubic meters of water per year to irrigate 31,800 hectares in the Doukkala.

- The Idriss-I dam will contribute to irrigate 7,000 hectares in the Loukkos basin.

- The Ait Chouarit dam will reserve 300 of the 350 million cubic meters it will regulate to meet the drinking-water needs of Marrakech (40 million cubic meters) and to irrigate 35,000 hectares in the Central Haouz area (260 million cubic meters).

- The projected Ibel Lakhal dam will regulate 85 million cubic meters to irrigate 4,500 hectares, including 1,800 hectares downstream from the dam and 3,000 hectares in the area covered by the Kaddoussa dam.

Hydroelectric Power Production

Our country has always tried to make the best possible use of its water resources, not only to meet the people's needs and the needs of agriculture, but also to produce electricity.

Thus, most dams built to-date are equipped with water-power plants which, in an average year, produce some 1.9 billion kWh, representing approximately 40 percent of the total 1980 requirements, i.e. 4.76 billion kWh. Since 1974, the steep rise in oil product prices has increased our country's dependence on foreign suppliers to meet its energy requirements. As a result, the 1981-1985 plan determined two major orientations concerning the selection of an electric-power production program:

- Priority will be given to the use and mobilization of our domestic primary energy resources, namely water, the Jerada coal and oil shale.

- Our supply sources will be diversified and imports reduced.

As far as the second orientation is concerned, the National Electricity Office, imitating in that other non oil-producing countries decided it would no longer build power plants that burn only fuel oil, and it is now and will keep using imported coal, for instance in a 60 MW power plant in Casablanca and at the Mohammedia power plant.

As far as the first orientation is concerned, we should note that:

- The Jerada coal production, which will increase from about 700,000 to 1 million tons/year, will supply only the Jerada and Casablanca power plants.

- The industrial use of oil shale will not be possible for another 10 years or so, the time required to develop combustion technology for this low-caloric value material (1,000 Kcal/kg) with a high ash content (10 percent).

- In view of the time required to design and build the first nuclear power plant, primary energy will not be available in our country for another 15 years or so.

The only remaining solution, therefore, is to use hydroelectric power to meet our increasing energy requirements until 1990.

A recent inventory showed that the total usable hydroelectric power production potential is about 4.6 billion kWh/year, 40 percent of which are already harnessed. Therefore, close to 2.8 billion kWh remain to be harnessed by dams; among the latter, the most important will be:

- the Ait Chouarit dam on the Lakhdar;
- the Dchar-el-Wadi dam on the Oum Er-R'bia;
- the M'jara dam on the Ouergha;
- the M'dez dam;
- the Upper Oum Er-R'bia dams (Imizdilfane, Tazgdert, Tajermout, El Borj, etc.)

The completion of these various projects will enable us to reduce our energy dependence on foreign countries.

Reorganization of Hydraulics Administration

Some reorganization has been taking place lately at the Ministry of Equipment; matters having to do with hydraulics will be centralized, but the new organization will also provide outside services in the regions and in the provinces.

[Question] What are the main characteristics of this new organization and what effect will it have on the Ministry of Equipment's operations?

[Answer] Indeed, the objective of the new organization is to achieve greater efficiency in carrying out tasks falling within the department's province.

As far as hydraulics are concerned, considering how acute water-related problems have become and what a wide range of operations are involved, it had become necessary to give hydraulics an important place in the department's operations.

Therefore, it was decided that the Directorate of Hydraulics would become the General Administration of Hydraulics, consisting of two central directorates:

- The first one, the Directorate of Water Research and Planning, is in charge of making an inventory, evaluating and controlling the country's water resources. In addition, it is now also in charge of planning the use of water resources and controlling their management.

- The second, the Directorate of Hydraulic Facilities, is in charge of the design and construction of large hydraulic equipment projects, and of their maintenance.

In the provinces, the department's outside services have been reorganized. The objective of this reorganization is to ensure a more uniform representation of the department in the provinces. Thus, Provincial Directorates of Equipment are created in each province to bring the citizens closer to the department's services. These Provincial Directorates include services corresponding to the fields of operation of the department.

Regionally, two structures have been created to guide the provincial directorates in the fields of equipment and water resources:

1. There are seven Regional Directorates of Equipment, one in each economic region. They are in charge of equipment surveys, research and planning. They will also supervise the Provincial Directorates.

2. The eight Directorates of Hydraulic Regions cover one or several hydrographic basins.

The Directorates of Hydraulic Regions will guide the Provincial Directorates in their operations related to water resources.

They will also be in charge of surveys dealing with the mobilization of water resources and the planning of their utilization.

In addition to these regional or provincial structures, there are temporary services in charge of large projects, whose functions end when the projects are completed.

Generally speaking, these are the main lines of the department reorganization.

[Question] Could you possibly give us a rapid overview of the concept of water planning?

[Answer] We all know that water is an essential factor in economic and social development. Now, Morocco has considerable water resources which represent a major asset in its progress and which must be managed rationally so all sectors of the national economy will benefit from them; this is becoming increasingly necessary considering the steady growth in water requirements and the incompatibility of certain uses, for instance agricultural uses and the production of hydroelectric power.

As a result, to prevent problems and set a water policy, His Majesty King Hassan II has decided to create a Higher Water Council that will coordinate opera-

tions in this sector and make the most advisable decisions on how to use water for our national economy.

The Directorate of Water Research and Planning of the Hydraulics Administration plays an important part in assisting this council: it provides its technical secretariat and prepares the preliminary studies required for major national orientations.

At present, the demand for water is increasing every year and it has become urgent to establish surface and ground-water utilization plans, for each hydrographic basin and for the national territory as a whole.

The objective of this planning task is to achieve rational use of available resources, without any waste, so that its scarcity will not become a limiting factor in economic and social development.

These planning studies require an accurate knowledge of resources, both with respect to quantity and quality; they will make it possible to plan the construction of the hydraulic facilities required to utilize our water resources and meet our requirements as they increase over the years.

They will also make it possible to prepare administrative provisions and regulations that will protect our water resources against any abusive overutilization and also protect the natural environment.

The Directorate of Water Research and Planning will be in charge of making these surveys jointly with the users involved (drinking water, agriculture, industry, energy, flood protection).

## Development of Mining Sector

Casablanca LE MATIN DU SAHARA in French 25 Feb 83 pp 6-7

[Article: "Results Obtained by the Mining and Energy Sector in 1982"]

[Text] 1 - Mining and Geology Sector

1.1 Geology: The geology sector, which is placed under the authority of the Directorate of Geology, has continued to establish maps and prepare the geological infrastructures required for mining-resources and water prospecting as well as for the construction of large equipment projects and industrial facilities and, more generally, for national and regional development.

As far as detailed maps are concerned, mapping of the national territory on various scales has been continued; it involves the preparation of surface-geology, buried-structures and geotechnical [as published] maps. In this respect, we should mention the 1/200,000-scale color map program that will cover our Saharian provinces, using aerial and satellite photographs; several models have already been completed, in particular those for Mijek, Bir Anzara and Twirerfaten.

As far as the geological synthesis map is concerned, we should mention in particular:

- The completion of the Moroccan mining deposit map to the scale of 1/500,000.

- The printing and publication of the first structural geology map of Morocco to the scale of 1/()000,000 [as published], including detailed geological sections through the country's major structural formations and a detailed analysis of structural alignments and lineaments.

- The printing and publication of the mining and energy map of united Morocco showing the country's mining deposits and energy infrastructure.

- The realization, from a mosaic of satellite photographs, of the first map of united Morocco, as seen from the satellite.

As far as marine geology is concerned, the preparation of bathymetric maps and a geological model of the kingdom's continental margin to the scales of 1/100,000 and 1/500,000 was continued. Still in that field, the Directorate of Geology has prepared surveys of the Straight of Gibraltar for the account of SNED [National Association for Straight Studies], the national company which studies a fixed connection across the straight.

1.2 Geological and Mining Prospection and Mining Exploration

Geological and mining prospection is the province of the Directorate of Geology, whereas mining exploration is chiefly carried out by public and private mine operators.

As far as geological prospection and the survey of mineral deposits are concerned, the Directorate of Geology has essentially directed its work to:

- Metallic deposits in the Upper Atlas and in Central and Eastern Morocco.

- Sulfur in the country's volcanic sediment formations.

- Uranium in the granitic Rehamna massif and in the phosphate-containing basins.

- Coal and lignite in the Boulmane, Oulad Abdoon and Tadla basins.

- Oil shale in formations underlying phosphate deposits.

- Useful substances: bentonite, asbestos, kaolin-containing clays, and construction materials in various regions of the kingdom.

As far as mining exploration is concerned, BRPM [Mineral Prospecting and Investment Office] oriented its work to follow the Five-Year Plan guidelines on fuel materials, precious metals, strategic metals, base metals and useful substances; encouraging results were reported for zinc (discovery of a large

deposit in Tiouli, in the Oujda region) and for precious metals, especially silver, in the Ouarzazate region.

Conclusive results were obtained by exploration work to prove mining deposits, the most important of which are listed in the table below:

| Name of Deposit | Province | Mineral | Geological Reserves | Contents |
|---|---|---|---|---|
| 1. Bou Maadine | Errachidja | Lead, zinc, gold, silver, sulfur | 5 million tons | Various |
| 2. Roc Blanc | Marrakech | Silver | Under study | |
| 3. Sidi Bou Azzou | Kalaa Es Sraghna | Tungsten | 850,000 tons | 0.18% $WO_3$ |
| 4. Jbel Khetam | Khenifra | Lead, silver | 1,077,000 tons | 3.7% Pb 60 g Ag/ton |
| 5. Zrahina | " | Fluor spar, baryte | 1,100,000 tons | Various |
| 6. Boudkek | Chefchaouen | Lead, silver, magnesite | 2,000,000 tons | 44% MgO |

During the next two or three years, new mines will be opened and these deposits will then reinforce our production potential.

For its part, OCP [Moroccan Phosphate Office] has continued its geological and mining surveys of the Meskala deposit in the Essaouira province.

Private mining companies have also made considerable financial efforts to discover new reserves to replace those now being mined.

1.3 Mining and Ore Benefication

As far as phosphates are concerned, mining and ore-processing facilities were further improved as scheduled during 1982.

- In the Khouribga district: A major realization was the placing into service of the Oued-Zem drying complex which was inaugurated by His Majesty the King in March 1982.

In addition, various improvements of the mining framework were completed and mining equipment purchased and placed into service at the Mera El Hrach landing and at bottom landing No 4, as part of the construction of the new mine in this sector, which is scheduled to start production in 1984 with a 4-million ton capacity.

The same is true of the corresponding processing facilities: a benefication process has been selected and equipment ordered, so the unit can start production in 1984.

In addition, the water-supply network that will provide the town with 120,000 cubic meters per day is nearing completion and will be placed into service during 1983.

- At Youssoufia: Equipment of bottom landing No 7 is nearing completion and production is scheduled to start early in 1983.

As far as landings Nos 8 and 9 are concerned, work on the mining framework and the equipment has been actively continued during the year.

It should also be noted that equipment for the new phosphate roasting facilities has been ordered.

- At Bou Craa: 1982 saw the completion of the overhauling of the mining, carrying, processing and shipping equipment, and production was resumed during the last few months of the year.

- At Sidi Hajjaj: Flotation-processing studies have been continued and mining of this deposit is scheduled to start in 1986.

We should point out that this project involves the creation of an open pit mine which, in a first stage, will have a capacity of 3 million tons of commercial phosphates that will be exported through Jorf Lasfar.

As far as other minerals are concerned, specific BRPM projects on the preparation of new mines involve mainly the following deposits: Bou Maadine in the Errachidia province, Roc Blanc in the Marrakech province, Sidi Bou Azzouz in the Kalaat As-Sraghna province, Jbel Khettem and Zrahina in the Khenifra province and, finally, Bou Dkek in the Chefchaouen province.

It should also be noted that the Sidi Bou Azzouz and Bou Dkek deposits are covered by a mining agreement under which they will be mined by a joint company consisting of BRPM, the German company Klockner and the Bulgarian company Geomine.

As far as artisanal small-scale mining is concerned, we should mention the start of the El Amal project in the Tafilalet and Figuig areas; it is designed to benefit mining artisans in these regions and the World Bank is financing two thirds of its cost, which is estimated at 79 million dirhams.

Outside the phosphate sector, the main mining realizations were the opening of the five following major mines:

1. The Bleida copper mine in the Ouarzazate province: it has multiplied fourfold our domestic production of that mineral (production of 55,000 tons of concentrate containing 35 percent copper).

The cost of the project has exceeded 260 million dirhams, including 74 million dirhams for the infrastructure.

2. The Tiouit and Asfalou mines in the Ouarzazate province: The annual commercial production of these mines will amount to 2,640 tons of concentrate containing 289 kg of gold, 6 tons of silver, 565 tons of copper and 202 tons of zinc.

The investments involved totalled approximately 55 million dirhams, including 6 million for the infrastructure.

3. The Zgounder silver mine (Taroudant province): Mining of this deposit will yield 73,000 tons/year of ungraded ore containg 500 [grams] of silver per ton which, after processing, will yield 32 tons of silver per year.

The cost of the project has exceeded 59 million dirhams, including 8 million for the infrastructure.

4. Sidi Lahcen mine (Oujda province): This unit will have an annual production of 5,567 tons of lead concentrates containing 74 percent of lead and 1,382 grams of silver per ton, plus 1,032 tons of zinc concentrate containing 74 percent zinc and 532 grams of silver per ton.

The total investments exceeded 62 million dirhams, including 9 million for infrastructure work.

5. Zelmou baryte mine in the Figuig province: It will produce 110 thousand tons of baryte, all of which will be exported through the port of Nador.

The cost of the project was close to 25 million dirhams; the project involved the creation of some 100 jobs in a region that is particularly underprivileged.

1.4 Upgrading of Mining Production:

1.4.1 Phosphates: The upgrading program of OCP has been continued in accordance with the orientations of the 1981-1985 Five-Year Plan. As a result:

- The fourth line, Morocco-Phosphorus I, reached its design production capacity in 1982. Its cost was 15 percent less than expected.

- The production at Morocco-Phosphorus II, which has a capacity of 1,500 tons of $P_2O_5$ per day, is increasing progressively.

- Work on Morocco-Phosphorus III and IV, which will have a total production capacity of 4,000 tons of $P_2O_5$ per day, has been progressing as scheduled. A large proportion of orders for phosphoric [acid production] were placed as separate batch orders.

The sulfuric acid plant was covered by a single batch order, and utilities are now being ordered.

The Jorf chemical complex will start production already in 1984.

- Morocco-Phosphorus North: This project is scheduled to start after the eight Jorf lines, starting in 1986. Credits for its infrastructures will be allocated shortly.

- Uranium: Work on the construction of the first stage of the Morocco-Chemistry and Morocco-Phosphorus I project in Safi, where uranium will be extracted from acids, is proceeding as scheduled. The first stage is scheduled to be placed into service in July 1985; it will have a production capacity of 250 tons of uranium oxide.

We should point out that, according to the present program, Morocco will produce between 2 and 3 thousand tons of uranium from phosphoric acid by the year 2000.

1.4.2 Other Minerals: These are essentially lead and copper.

BRPM studies of lead and copper smelting led to the following conclusions:

- A copper smelter and refinery will be built in the Essaouira area, so it can use a domestic source of energy, gas.

- The Oued El Heimer lead smelter near Oujda will be enlarged so it can process the whole Moroccan lead-concentrate production.

With respect to the first project, an agreement has been signed between the Moroccan Copper Smelter Company, SOFOMAC, and the Belgian company Machim concerning a feasibility study scheduled to be completed in February 1983.

The production objectives of this project are as follows:

- 20,000 tons per year of electrically refined copper, most of which will be sold on the local market.

- 25,000 tons per year of blister copper for exportation.

The project site is now being purchased.

Financing for this project (estimated at 672 million dirhams) has already been secured, especially thanks to the participation of several Arab countries and organizations.

As for the Zellidja lead smelter expansion project, a study has been initiated to see how its processing capacity could be increased from the present 100,000 tons of concentrate to 160,000 tons, and work is scheduled to start in 1983.

Finally, we should mention several studies by the Directorate of Mines and BRPM on the upgrading of the Boudkek magnesite in the Chefchaouen province, the Kettara pyrrhotine in the Marrakech province, the Khemisset potash and the Safi gypsum.

In addition, the Ministry of Energy and Mines has informed the Ministry of Industry of production programs for refined metals, especially copper, so

measures can be taken to process these metals locally into finished products that would replace imports.

To conclude this review of mining, we should point out that the geographical situation of Morocco with respect to large complexes that import mineral raw materials, as well as the quality of its deposits, the diversity of the minerals mined--which cover practically the whole range of products used by the industry--and, finally, its present policy of upgrading its mining production in the country are as many positive factors which have enabled our country's mining industry to withstand the disastrous effects of the world economic crisis which has brought about a sharp decline in many countries' export receipts.

In addition, these detrimental effects have not in any way affected our country's mining development programs. Thus, 1.403 billion dirhams were devoted to that development in 1982, as follows:

- Mining prospection: 181 million dirhams.
- Ore mining and benefication: 576 million dirhams.
- Processing: 286 million dirhams.

Program of Action For the Mining Sector, For 1983 and the Following Years:

This program will still follow the guidelines contained in the 1981-1985 Five-Year Plan.

As far as mining exploration is corcerned, priority will be given to solid fuels, especially coal, precious and strategic metals, and industrial materials.

Exploration will be extended to new areas, especially the Saharian provinces, starting in Tata.

As far as mining is concerned, the OCP program will be continued in the mining districts of Khouribga, Roussoufia, Sidi Hajjaj and Bou Craa, as will preparatory work on the Meskala deposit.

For the other minerals, investment efforts will involve chiefly the development of the Jerada coal mines and the preparation of new mines covered by specific BRPM projects whose economic interest was demonstrated in 1982, especially with respect to the lead, fluor spar, magnesite, tungsten and silver deposits listed in a table above.

As far as local processing of our mining products is concerned, implementation of the policy adopted in this field will be continued, especially with respect to the large Jorf Lasfar phosphate complex, the Essouira copper smelter project and the Ouel El Heimer (East Morocco) copper smelter extension project.

As a result, the country's global mining investment effort will be actively continued in 1983, when over 4.35 billion dirhams will be spent, including 3.94 billion for phosphates, as follows:

| Category | Million Dirhams | Percent |
|---|---|---|
| Mining exploration | 219 | 5 |
| Mining and upgrading | 4,131 | 95 |

As far as mining economy is concerned, a qualitative and quantitative recovery is expected, due to an increase in the production of finished and semi-finished products and to a rise in ore prices, which should result in an appreciable increase in receipts in 1983.

Considering that crude oil prices are expected to settle down, this recovery will have a beneficial effect since our mining sector exports will more adequately cover our oil imports.

3. The Energy Sector

The energy sector is the prime mover of any economy. In our country, the government's debate on the National Energy Plan has confirmed that this is a priority sector whose development is given special attention by the authorities.

The object of the debate was to determine the best means to ensure that the plan would be implemented in the medium and long term and, as far as the short term is concerned, to look for ways to resolve the financial difficulties that hinder its progress.

In spite of the difficulties experienced by this sector during the year--which at times have been extreme--the Ministry of Energy and Mines has taken all necessary measures to ensure, on the one hand, that the whole country will be supplied with oil products and, on the other hand, that the development of this sector will proceed under satisfactory conditions.

3.1 Electric Power Production and Transmission

Work done in 1982 involved:

3.1.1 Hydroelectric Power Plants

- Continuation of the work on the Lalla Takerkoust plant (2 x 6 MW).

- Continuation of field work for the Amouggez plant (67 MW).

- Realization of studies to prepare technical specifications and invitations to bid for a number of projects: Matmata (246 MW), Mdez (53 MW), El Menzel (148 MW), Dchar El Oued (92 MW), M'Jara (240 MW), Mrija (60 MW), Sebkhat Tah (8-10 MW).

- Survey of three micro-power-plant sites: Tinkhar N'Ifni (225 kW), Aghbalou N'Kerdous (75 kW) and Taben (225 kW).

3.1.2 Thermal Power Plants

- Placing into service of the second stage of the Mohammadia power plant (150 MW).

- Studies and work on the utilization of oil shales at the Timahdite power plant.

- Continuation of infrastructure preparatory work prior to adding nuclear power plants to the national network, starting in 1995.

3.1.3 Transportation and Distribution Network

- Expansion of the Zaers station and construction of the Zaers-Mohammadia very high voltage power line.

- Construction of the Selouane station and of the Selouane-SONASID [National Steel Company] line.

- Work on the 225 kV lines to evacuate the electric power produced at the Mohammadia power plant.

- Extension of the 60 kV network to reach outlying areas.

3.1.4 National Rural Electrification Program (PNER)

Under the PNER, 1,000 additional centers will be connected to the power-distribution network by 1995, thus increasing the rural electrification rate to 35 percent.

In a first stage, 254 centers distributed throughout the kingdom will be connected to the distribution network between now and 1985. Work on this first stage started early in 1983.

3.1.5 Electrification of Saharian Provinces

Studies and preliminary work were carried out concerning the construction of production facilities and the extension of the distribution network to Laayoune, Smara, Boujdour, Dakhla, Tarfaya and Foum El Oued.

In addition, the existing Diesel-fuel power plants were upgraded during the year.

Investments in the electric-power sector amounted to 600 million dirhams, as follows:

| | | | |
|---|---|---|---|
| - Hydroelectric power | 32 | million | dirhams |
| - Thermal power | 374 | " | " |
| - Transportation | 88 | " | " |
| - Distribution | 36 | " | " |
| - Miscellaneous improvements | 70 | " | " |

3.2 Oil Products:

3.2.1 Refining: additions were made to the SCP [Moroccan Petroleum Company] Sidi Kacem refinery, and its processing capacity now exceeds 1.1 million tons per year.

By the end of 1982, the country's crude oil processing capacity thus reached 8.7 million tons per year.

As for lubricating oils, the Mohammadia project has now reached an advanced stage of completion: 60 percent by the end of 1982.

3.2.2 Storage

Storage facilities for oil products are necessary to ensure national and regional supplies under the best possible conditions; underground storage of gas in the salt mines located near Mohammadia will be developed thanks to a second cavity with a capacity of 120,000 tons of butane.

In addition filling stations have been realized at Kenitra and Jorf Lasfar.

Investments in the distribution sector amounted to 557 million dirhams in 1982.

3.3 Development of Energy Resources

3.3.1 Coal: Considerable exploration work, involving geophysical, drilling and mining work, has been accomplished to develop the Jerada deposit reserves.

3.3.2 Oil Prospecting:

1982 saw a revival of oil prospecting: in the Essaouira and Gharb basin, 16 drillings totalling 30,000 meters were made, compared with only 10 drillings and 19,000 meters in 1981. Also, international oil companies, especially U.S. companies, showed considerable renewed interest, and three agreements involving close to 220 million dollars were signed with these companies during the year.

We should also mention that the World Bank has intensified its aid to Moroccan oil prospecting; it granted another 75-million dollar oil loan to the National Office for Oil Prospecting and Development [ONREP].

1982 expenditures amounted to 387 million dirhams compared with 265 million in 1981, i.e. a 46 percent increase.

Of this total, 240 million dirhams, i.e. 63 percent, were financed by the World Bank and partner companies.

3.3.3 Oil Shale:

Construction of the Timahdite pilot plant, which is entirely financed by the World Bank, started last October. This unit will be completed during the second quarter of 1983 and will operate for about a year to determine all parameters necessary for the realization of industrial units.

As is known, these units are using the national T3 process; they will each have a production capacity of 100,000 tons of shale oil per year.

3.4 Renewable Energy Sources: Plans for the construction of the Marrakech Renewable Energy Development Center were completed and, in addition, the following pilot projects were started:

- Site surveys for three micro power plants in the Ouarzazate, Errachidia and Azilal provinces;

- Construction of a methane digester in Marrakech;

- Construction of a solar furnace at the Temara training farm of the Department of Agriculture;

- Construction of a water distiller at the Marrakech School of Mines;

- Study of a solar pumping system for the village of Beni Oukil in East Morocco.

Most of these projects are carried out in cooperation with USAID.

3.5 Energy Savings:

1982 was marked by the work of the National Energy Commission, a sub-commission of which submitted to the government a report on potential energy savings.

We should also mention the creation of an energy savings service at the Directorate or Energy, and the establishment of cooperation in this field with other ministerial departments (Industries, Plan, Transport), as well as with specialized foreign organizations such as USAID and the French Agency for Energy Control.

Overall, 1982 energy-related investments amounted to 1.72 billion dirhams, including 600 million for electric power, 557 million for oil products and 563 million to develop energy resources (including 387 million for oil prospecting).

Planned work scheduled for 1983 will conform to the objectives set in the National Energy Plan.

a. In the electric power sector:

Production of 5,880 GWh, including 1,450 from water-power plants and 4,430 from thermal power plants (+ 9 percent over 1982).

The work program includes in particular:

- The placing into service of the Lalla Takarkoust hydroelectric power plant in the Marrakech provinces.

- Continued work on stages 3 and 4 of the Mohammadia power plant (scheduled to be placed into service in 1984).

- Continued work on the Ammougguez hydroelectric power plant.

- Construction start-up on the Tah hydrosolar project and the Matmata (Fes province) and Dchar El Oued (Beni-Mellal province) hydroelectric power plants.

- Further site inventory studies for the construction of hydroelectric power plants, and feasibility studies and site surveys for projected micro power plants, solar and biomass projects, and studies concerning the introduction of nuclear power plant.

- Extension of the electric power transmission network.

- Start-up of work scheduled for early 1983 under the PNER, if credits are made available in time, including scheduled expenditures of 150 million dirhams.

- Scheduled credits for this program of action amount to close to 950 million dirhams.

b. As far as coal is concerned: Work will continue on the mechanization of coal breaking, to increase production to 790,000 tons in 1983.

The investment scheduled to this end amounts to 134 million dirhams.

c. As far as oil prospecting is concerned: Oil prospecting will enjoy new expansion in 1983 and will involve:

- An assessment of the Mescala structure and the development of the Gharb gas fields.

- An intensification of prospecting in other regions of the kingdom, through an exceptional program involving the following basins: Boudnib high plateaux, Prerif, Guercif, Doukkala, Middle Atlas, and Tarfaya offshore.

The realization of this program will require: nine drilling systems, including four of our own, one given by Kuwait and delivered in December 1982, and four that are leased.

In addition, our partner companies will also develop their operations: Amoco in the Mediterranean, Arco off Agadir, Mobil off Tarfaya and, probably, the

Kuwaiti KPC [Kuwaiti Petroleum Company] in the Essaouira, Koukkala and Boudnib basins.

Thus, the cost of the 1983 oil prospecting program amounts to close to 1.6 billion dirhams, including 228 million financed by IBRD [International Bank for Reconstruction and Development] and 500 million by partner companies under existing agreements.

d. Oil shale: The 1983 program includes mainly:

- Completion of construction work on the T3 pyrolysis pilot plant, and the issuance of invitations to bid for the first 200-MW stage of the Timahdite oil shale power plant.

- Completion of work in relation with the Tosco-Paribas agreement, and presentation of the final survey report.

- Six deep drillings to assess the underground water potential of Timahdite.

- Preparation of a report on the first stage of the tentative agreement with Shell concerning the Tarfaya deposit.

- Realization of a comprehensive study of environmental problems and of a mining survey prior to mining the Timahdite deposit.

Scheduled expenditures amount to 108 million dirhams, part of which will be financed by the IBRD.

e. Renewable energies:

The main projects to be realized in 1983 are as follows:

- Three micro power plants in the Arrachidia, Ouarzazate and Azilal provinces.

- Electrification of a tourist village in the Al Hoceima provinces.

- A solar pumping unit in the Souss [region].

- A desalination plant in the Tarfaya province.

- An agricultural pumping station at Beni-Oukil, in the Oujda province.

Credits for this project, 53 million dirhams, include 18 million dirhams in USAID credits.

f. Energy savings:

1983 will see:

- The launching of an information campaign and the organization of a seminar.

- A survey of energy consumption, extending over one full year.

- The completion of a survey of energy transport.

- The realization of an evaluation study of Morocco's major industries in cooperation with the French Energy Institute.

- The evaluation of the tidal power potential of the Moroccan coast.

All together, 1983 investments in the energy sector are estimated at 3.34 billion dirhams, half of which will go to oil prospecting.

4. Vocational and Cadre Training

While continuing its development investments, the Ministry of Energy and Mines has also given a lot of consideration to vocational training in its program of action.

Thus, the National School of Mining Industry, which is placed under the authority of that department, has had its training level upgraded: it is now training state engineers who graduate after a six-year course of studies including two preparatory years.

The range of technical disciplines taught in that school has also been expanded; in addition to the traditional mining options (geology, ore mining and processing, and steelmaking), three new options are now being offered: electromechanical engineering, chemical engineering and energy science.

The School's research and development facilities have also been upgraded by the addition of a rock-mechanics laboratory, and especially the installation of an applied-research nuclear reactor of the Triga Mark I type.

The graduating-year level of the Marrakech School of Mines has also been upgraded; starting with school-year 1982-1983, it will produce higher technicians in the various mining disciplines.

In addition, in order to provide prerequisites for the success of the national nuclear power plan, the Ministry of Energy and Mines has increased the number of young engineers and university graduates who are sent abroad to receive specialized training.

Considering the highly specific nature of this training, an additional program was developed in cooperation with the International Atomic Energy Commission: it will extend over several years and includes well-defined objectives with respect to nuclear site surveys, technical plant control, fuel preparation, radiation protection and protection of the environment as a whole.

In 1982, the energy and mining sector trained some 100 engineers and over 1,100 technicians at various levels.

| Mining Products (Tons) | 1981 | 1982 | % Variation 1982-1981 |
|---|---|---|---|
| Phosphates | 18,682,284 | 16,646,000 | - 10.8 |
| Anthracite | 703,000 | 738,000 | + 4.9 |
| Iron ore | 73,112 | 198,000 | + 170.8 |
| Lead | 168,078 | 154,000 | - 8.3 |
| Copper | 22,558 | 64,000 | + 183.7 |
| Zinc | 14,720 | 19,000 | + 29 |
| Silver metal | 22 | 25 | + 133.6 |
| Antimony ore | 1,140 | 2,000 | + 75.4 |
| Chemical-grade manganese | 109,647 | 109,000 | - 0.6 |
| Cobalt ore | 6,265 | 6,000 | - 4.2 |
| Fluor spar | 66,700 | 42,500 | - 3.6 |
| Barite | 465,660 | 418,000 | - 10.2 |
| Pyrrhotine | 78,938 | | - |
| Salt | 55,197 | 60,000 | - 8.7 |
| Ghassoul (red clay) | 8,670 | 4,000 | - 5.3 |
| Total | 20,455,991 | 18,460,545 | - 9.7 |

| Mining Products (Tons) | 1981 | 1982 | % Variation 1982-1981 |
|---|---|---|---|
| Phosphates | 15,635,480 | 13,591,000 | - 13 |
| Anthracite | 60,733 | 40,000 | - 50.6 |
| Iron ore | 70,242 | 240,000 | + 241.6 |
| Lead | 83,586 | 77,000 | - 7.8 |
| Copper | 21,093 | 6,000 | + 184.4 |
| Zinc | 17,164 | 20,000 | + 16.5 |
| Silver metal | 20 | 27 | + 35 |
| Antimony ore | 1,240 | 1,700 | + 37 |
| Chemical-grade manganese | 98,415 | 107,000 | + 8.7 |
| Cobalt ore | 6,210 | 6,600 | + 6.2 |
| Fluor spar | 55,100 | 55,500 | + 0.7 |
| Barite | 338,482 | 341,000 | + 0.7 |
| Ghassoul (red clay) | 1,477 | 4,000 | + 170.8 |
| Total | 16,389,242 | 14,533,827 | - 11.3 |

These figures will of course increase as greater efforts are devoted to training.

5. Organization and Structure Reinforcement

The efforts made by the Ministry of Energy and Mines to carry out development programs in the national energy and mining sector also involved improving the organization of this sector and reinforcing its structure.

Thus, the creation of ONREP was completed in 1982 and BRPM was reorganized; it will now devote itself only to mining development.

Processed Products: Production (in Tons)

| Products | 1981 | 1982 | % Variation 1982-1981 |
|---|---|---|---|
| Phosphate derivatives | | | |
| - $P_2O_5$ | 738,734 | 1,015,169 | + 37.4 |
| - MAP | 30,736 | 149,205 | + 385.4 |
| - NPK | 47,816 | 67,946 | + 42 |
| - ASP | 85,625 | 77,942 | - 8.9 |
| - TSP | 265,980 | 270,054 | + 1.5 |
| Subtotal | 1,138,155 | 1,580,316 | + 38.8 |
| Lead metal | 50,149 | 53,300 | + 6.2 |
| Silver metal | 19.15 | 25 | + 30.5 |
| Copper matte | 2,663 | 3,200 | + 20.1 |
| Subtotal | 52,831.15 | 56,525 | + 7 |
| Total | 1,190,986.15 | 1,636,841 | + 37.4 |

Processed Products: Exports (in Tons)

| Products | 1981 | 1982 | % Variation 1982-1981 |
|---|---|---|---|
| Phosphate derivatives | | | |
| - $P_2O_5$ | 548,895 | 715,529 | + 30.3 |
| - MAP | 23,472 | 132,123 | + 462.8 |
| - TSP | 233,280 | 259,946 | + 11.4 |
| Subtotal | 805,647 | 1,107,598 | + 37.5 |
| Leal metal | 47,905 | 54,000 | + 12.7 |
| Silver metal | 18.3 | 21.3 | + 16.4 |
| Copper matte | 2,358 | 3,800 | + 61.1 |
| Subtotal | 50,281.3 | 57,821.3 | + 15 |
| Total | 855,928.3 | 1,165.419.3 | + 36.1 |

A law and a decree concerning the creation and the organization of the Renewable Energy Development Center were also promulgated.

In addition, the National School of Mining Industry was given the status of public institution, which will place it in a better position to fulfill its mission of training higher cadres.

To prepare the basic infrastructure necessary for the introduction of nuclear energy into our country by the early 1990's, a bill concerning the creation of a National Nuclear Research Center was prepared and submitted to government authorities.

Another bill deals with the creation of a Higher Energy Council.

Finally, we should mention that the following bills have now been finalized:

- mining regulations (mining code);
- mining investment code;
- regulations on explosives (manufacturing, storage, sale and use);
- law on the storage and use of radioactive materials and radiation protection;
- a first bill on pollution and environmental problems in the mining industry.

## Domestic Demand for Energy

Casablanca LE MATIN DU SAHARA in French 26 Feb 83 pp 10-11

[Article: "Prospects for Evolution in the Energy Sector"]

> [Text] The country's energy consumption doubles every eighth year. The two major orientations of the present development plan are:
>
> - Utilization and mobilization of our domestic primary energy reserves;
>
> - Diversification of our foreign supply sources.

Forecasts of future electricity requirements undertaken by ONE [National Electricity Office] early in 1980 and updated during the first quarter of 1981 show that, under present economic conditions, the average rate of growth of the total energy requirements of all Public Distribution stations during the coming decade should range from 8 to 10 percent.

As a result, the equipment program for the period 1981-1990 was based on an average rate of growth of the demand of 9 percent per year (i.e. demand doubles every eighth year).

Based on these studies, the peak winter energy and power requirements that must be covered are as follows:

- 1980: 4,762 GWh and 855 MW
- 1985: 7,300 GWH and 1,300 MW
- 1990: 11,300 GWh and 2,000 MW
- 1995: 17,300 GWh and 3,035 MW
- 2000: 26,700 GWh and 4,635 MW

A sensitivity study was also made to determine the incidence that a 1 percent increase in the rate of growth of the demand over and above the figure used in the basic assumption would have on the equipment program.

Considering the massive rise in oil product prices and our country's increasing dependence on foreign supply sources, the two major orientations of the plan with respect to the selection of an electric-power production equipment program were as follows:

2. Hydrosolar facilities (not connected to the interconnected network).

- Sebkha-Tah (8 to 10 MW); during 1988.

3. Thermal and oil-shale power plant

- Timahdite (1 x 100/125 MW or 1 x 200/250 MW); testing to start in 1987; start-up late in 1990.

Projects to Be Studied During the Present Five-Year Plan

- 22 hydroelectric projects with a total installed power capacity of approximately 1,000 MW and a mean productibility of close to 1,500 GWh.

- Four to five 250/200 MW oil-shale units; in a first stage, an experimental unit will be placed into service early in 1987.

- One or several thermal units using substitute coal, in view of the options selected with respect to hydroelectric power plants and the use of oil shale.

- A first nuclear power plant: feasibility studies, site survey, personnel training, study of contract conditions and technical specifications, preparation of estimates, analysis of financial capabilities, studies of legal aspects and regulations, etc.

These studies will be followed by the preparation and the publication, during 198? [as published], of invitations to bid for the construction of a first power plant consisting of 600 MW units and to start construction work so the plant can be placed into service as scheduled late in 1996.

- Small hydroelectric projects: study and construction of micro hydroelectric power plants in remote centers, especially in the high Atlas and Rif valleys.

- Solar power plants: Technical and economic feasibility studies for micro solar power plants to be built in remote areas with long periods of sunshine.

- Alfa-burning power plants: technical and economic studies.

As far as the transmission network is concerned, work on the 225-kV network will involve, on the one hand, the connection of thermal and hydroelectric power plants (400 km of lines and twenty 225-kV switch bays) and, on the other hand, the extension of the 225-kV network to the whole national territory (800 km of lines, including 452 km of 150-kV lines to be changed to 225 kV, thirty-five 225-kV switch bays, and a transformation capacity of 2,000 MVA).

As far as the 60-kV network is concerned, the realizations will involve 1,000 km of lines, one hundred and twenty 60-kV switch bays, and a transformatior capacity of 600 MVA.

- Utilization and mobilization in priority of our national primary-energy reserves represented by hydroelectric power, the Jerada coal, oil shale and uranium.

- Diversification of our foreign fuel supply sources, especially through the importation of coal.

Thus, in addition to completed projects and projects under construction (Mohammadia power plant), the program of action provides for the progressive utilization of the hydroelectric potential that remains to be harnessed, which represents 2.8 billion kWh.

The program provides that six hydroelectric projects, for which preliminary work is practically completed, will be started and completed during the five-year period 1981-1985; these projects represent a total installed power capacity of 840 MW, with a mean annual productibility of 1,340 GWh and a guaranteed productibility of 765 GWh: Amougguez, Dchar, El M'Ddez, Matmata and M'Jara are multi-purpose projects, whereas El Menzel will only produce power. These projects are scheduled to be placed into service in succession from 1986 to 1990.

The equipment program adopted includes three types of production projects:

Projects to Be Completed After 1980

- Completion of the Idriss-I (2 x 20 MW), Oued El Makhazine (1 x 36 MW) and Al Massira (2 x 64 MW) power plants; the latter was placed into service during the 1978-1980 Plan.

- Takerkoust hydroelectric power plant (2 x 6 MW), to be placed into service by mid-1983 (remodelled plant).

- Mohammadia steam power plant:

  - fuel-oil units (2 x 150 MW) placed into service in November 1981 and February 1982;

  - coal-burning units (2 x 150 MW): late in 1984 and early in 1985.

Projects to Be Undertaken During the Five-Year Period 1981-1985

- Planning defined as a function of the evolution of the demand for electricity and the agricultural development program:

1. Hydroelectric power plants; start-up

- Ait Chouarit-Amougguez (1 x 67 MW); late in 1986.
- Dchar El Oued (1 x 92 MW); late in 1987.
- M'Jara (3 x 80 MW); late in 1989, early in 1990.
- M'Dez (1 x 52 MW); during 1988.
- Matmata (3 x 80 MW); during 1988, late in 1988.
- El Menzel (2 x 74 MW); early in 1990.

Production of Electric Power by Source of Energy - 1980-2000
(Average Annual Rate of Growth: 9 Percent)

| Energy Source | 1980 GWh | 1980 % | 1985 GWh | 1985 % | 1990 GWh | 1990 % | 1995 GWh | 1995 % | 2000 GWh | 2000 % |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Jerada coal | 980 | 20 | 1,450* | 20 | 1,450* | 13 | 1,450* | 9 | 1,450* | 6 |
| 2. Hydroelectric power | 1,515 | 32 | 1,940 | 27 | 3,445 | 30 | 4,365 | 25 | 4,615 | 17 |
| 3. Oil shale | - | | - | | 150 | 1 | 5,000 | 29 | 5,000 | 19 |
| 4. Nuclear power | - | | - | | - | | 3,000 | 17 | 13,400 | 50 |
| 5. Imported coal | - | | - | | - | | 2,100 | 12 | 2,235 | 8 |
| 6. Fuel oil | 2,267 | 48 | 2,110 | 29 | 4,155 | 37 | 1,385 | 8 | | |
| 7. Total | 4,762 | 100 | 7,300 | 100 | 11,300 | 100 | 17,300 | 100 | 26,700 | 100 |
| Proportion of electricity requirements covered by domestic primary energy sources (1+2+3+4)/7 | | 52 | | 47 | | 44 | | 80 | | 92 |

* Production of power plants using the Jerada coal (Jerada thermal power plant and Unit II of R.N. [expansion unknown]).

Plants using domestic coal are supposed to be replaced after 25 years in operation to burn the 835,000 tons of small coal included in the total production of 1 million tons of coal which, according to the CNAs [expansion unknown], will be reached by 1985 (Mining of Works V and mechanization).

Expenditures for Equipment During the 1981-1985 Five-Year Plan

Expenditures included in the general program (Table I.1) during the 1981-1985 Five-Year Plan, as published in March 1981, amount to 3,946,058,000 dirhams, with the following breakdown:

- 939,924,000 dirhams for hydroelectric power production, i.e. 23.8 percent;

- 2,026,129,000 dirhams for thermal power production, i.e. 51.3 Percent;

- 575 million dirhams for the transmission network, i.e. 14.6 percent;

- 150 million dirhams for the distribution network other than that financed by the Special Fund, the Regional Development Fund and budget credits, i.e. 3.8 percent;

- 255 million dirhams for auxiliary facilities, i.e. 6.5 percent.

Investment forecasts for 1981, as published in March 1981 in the 1981-1985 Plan expenditure forecasts, amounted to 560,158,000 dirhams.

However, a number of factors led to a downward revision of estimated 1981 expenditures.

As a result, the 1981 foreseeable investment expenditures will amount to 376,658,000 dirhams, i.e. 183,500,000 less than originally published in the March 1981 forecasts.

Table II below [as published] gives the new breakdown of expenditures for the Plan period.

In addition to these planned projects, some of the work performed is not covered by the Plan:

- 164 million dirhams from the Special Fund, if operating results allow it;

- 870,000 dirhams from budget credits;

- 110 million dirhams from special credits for the equipment of Saharian provinces;

- 339,735,000 dirhams from PNER;

- 364 million dirhams from third parties.

Production Equipment

The energy policy has now become a constant concern of governments in most countries, especially those which must rely on oil for their energy supply.

In particular, developing countries which are oil importers, like Morocco, must absolutely reduce to a minimum their dependence on imported oil products through the implementation of an energy policy adapted to the new situation created by the rise in oil prices, as oil now covers approximately 85 percent of our country's primary energy consumption, and 50-70 percent of its electric power requirements (depending on the rainfall).

Since our primary energy consumption increases at an average rate of 6-7 percent per year, and our demand for electric power at an average rate of 9 percent per year--which means that demand doubles every eighth year--our dependence will get worse during the coming decade.

As a result, the choices that were made in defining our national energy policy were based on a number of orientations, in particular the accelerated mobilization of our hydroelectric potential that remains to be harnessed, the development of the exploration and mining of domestic coal deposits, the use of imported coal in preference to fuel oil, the upgrading of oil shale, the introduction of nuclear energy, the development of renewable energies, a more rational energy consumption and incentives to save energy.

If we consider how much each domestic primary energy source could contribute in covering the electric power demand of public distribution networks, we note that:

- As far as hydroelectric power is concerned, the most recent inventory shows that the total potential that could be used economically represents some 4.6 billion kWh, about 40 percent, i.e. 1.9 billion kWh, of which are already harnessed.

The remaining potential, i.e. close to 2.8 billion kWh, could be harnessed by the year 2000 through the construction of some 30 new plants that would be placed into service progressively and would meet busy and peak hour requirements.

Harnessing this potential would result in fuel oil savings of some 700,000 tons per year.

- As far as coal is concerned, the present equipment of the Jerada mine does not make it possible to mine more than 1 million tons, 700,000 of which are already consumed at the mine, in the thermal power plant consisting of three 55-MW units with a productibility of 1.15 billion kWh (the equivalent of 0.35 million tons of oil).

A research program is contemplated to increase production capacity to 1.2 million tons after 1985, 850,000 tons of which would then be consumed in National Electricity Office power plants.

In addition, to reduce our dependence on oil products, on the one hand, and to diversify our foreign fuel supply sources, on the other hand, the substitution of imported coal for fuel oil will be systematically considered in all cases where its technical and economic feasibility has been demonstrated.

Should it be confirmed that the natural gas deposit recently discovered at Meskala contains enough reserves to warrant production, substitution of this gas to fuel oil in existing thermal power plants and in plants under construction would be considered and would alleviate our dependence on oil. The fuel oil savings that could be achieved by 1990 in existing thermal power plants already designed to burn gas and in those that could be readily converted to burning gas, would represent some 1.5 million tons.

- As for oil shale, especially oil shale from Timahdite in the north of the country, its use to produce electricity through direct combustion cannot take place before 1991, as the combustion technology for this fuel--which has a very low caloric value--will first have to be developed in a prototype unit of approximately 200-MW, consisting of two 100-MW boilers, testing on one of which is scheduled to start in 1987.

When all prerequisites for the realization of a 1,000-MW power plant project at Timahdite have been met (development of direct combustion technology, mine equipment, water supply, ash disposal, etc.), thermal power production from shale in 1998, when the plant is expected to have reached steady running conditions, would amount to 5 billion kWh, which would save the country close to 1 million tons of fuel oil per year.

If we consider the overall electric power production, we note that, as far as covering the electric power demand of public distribution networks is concerned, the rate of coverage of electric power requirements from domestic primary energy sources would reach approximately 90 percent by 2000, including 20 percent produced from oil shale.

Considering the country's potential production of uranium, especially uranium contained in phosphates, it is obvious that sooner or later our country will have to use nuclear power plants to produce electricity, if we are to reduce our dependence on imported fossil fuels. Uranium will also be an effective means of diversifying our fuel supply sources.

Considering the evolution of the demand set up of our domestic network, it will not be possible to introduce nuclear power into our production system before 1997, when the domestic demand set up would reach approximately 3,500 MW, which would make it possible to add units of 600-MW--the present standard minimum--to the network under satisfactory conditions of operational safety.

Now, the study and construction of the first nuclear power plant are expected to take quite a long time:

- four years for feasibility studies and site survey;

Key to graph:

1. Evolution of the demand for electricity of public distribution networks (year of average rainfall) 1980-2000
2. Fuel oil
3. Nuclear power
4. Oil shale
5. Hydroelectric power(1)
6. Jerada coal (Jerada + Unit II of RN)
7. Imported coal
8. Hydroelectric program determined as a function of the evolution of the demand for electricity of public distribution networks and of agricultural requirements, adjusted to conform with the Plan.
9. Years

- two to three years for preparation, invitations to bid, analysis of the bids, selection of the prime contractor and the negotiation of construction and financing agreements;

- seven to eight years for the construction and the necessary adjustments prior to operation.

Therefore, it will take 13-15 years between the start of the studies and the industrial operation of the power plant; this means that the first plant cannot be added to the Moroccan network before 1997.

The nuclear power program contemplated for the year 2002 involves placing four 600-MW units into service between 1997 and 2002, at the rate of one unit every other year or so.

If this nuclear power program is implemented, over 90 percent of the electricity demand of public distribution networks will be covered by domestic primary energy sources, and approximately 50 percent by nuclear power.

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